Exercise 3.7.2

Find the Mayer–Norton equivalent circuit for the circuit below.
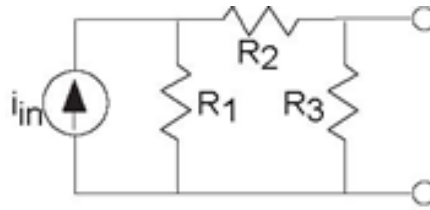

Figure 3.21 Circuit for exercise

Equivalent circuits can be used in two basic ways. The first is to simplify the analysis of a complicated circuit by realizing the any portion of a circuit can be described by either a Thevenin or Mayer–Norton equivalent. Which one is used depends on whether what is attached to the terminals is a series confguration (making the Thevenin equivalent the best) or a parallel one (making Mayer–Norton the best).

Another application is modeling. When we buy a fashlight battery, either equivalent circuit can accurately describe it. These models help us understand the limitations of a battery. Since batteries are labeled with a voltage specifcation, they should serve as voltage sources and the Thevenin equivalent serves as the natural choice. If a load resistance R_L is placed across its terminals, the voltage output can be found using voltage divider :

$$v = \frac{v_{eq} R_t}{R_L + R_{eq}}.$$

If we have a load resistance much larger than the battery's equivalent resistance, then, to a good approximation, the battery does serve as a voltage source. If the load resistance is much smaller, we certainly don't have a voltage source (the output voltage depends directly on the load resistance). Consider now the Mayer–Norton equivalent; the current through the load resistance is given by current divider, and equals

$$i = - \left(\frac{i_{eq} R_{eq}}{R_L + R_{eq}} \right).$$

For a current that does not vary with the load resistance, this resistance should be much smaller than the equivalent resistance. If the load resistance is comparable to the equivalent resistance, the battery serves **neither** as a voltage source or a current course. Thus, when you buy a battery, you get a voltage source if its equivalent resistance is much **smaller** than the equivalent resistance of the circuit to which you attach it. On the other hand, if you attach it to a circuit having a small equivalent resistance, you bought a current source.